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Canadian Science Advisory Secretariat
Science Advisory Report 2010/044

STOCK ASSESSMENT ON SCALLOP OF THE INSHORE WATERS OF QUEBEC IN 2009

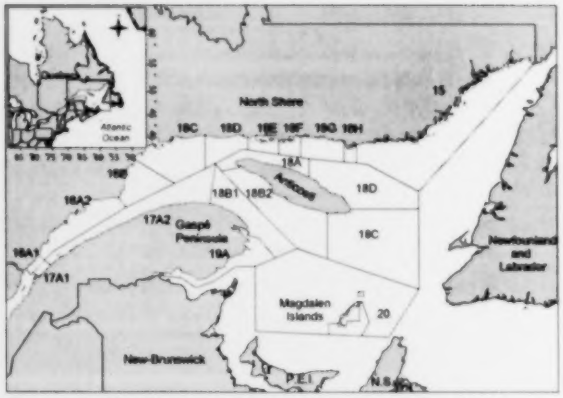

Figure 1. Scallop management Areas in Quebec.

Context

The commercial scallop fishery in Quebec began in the late 1960s. It is an inshore fishery that targets two species indiscriminately, namely sea scallop (Placopecten magellanicus) and Iceland scallop (Chlamys islandica). Catches are landed mostly as meat (muscle), but the proportion landed in the shell has been growing since the late 1990s. The region is divided into 19 management units (Figure 1) with 80 permanent fishing licences and 2 exploratory licences. Fishing effort is controlled in all units, while catches are controlled in some units.

The resource is assessed every three years to determine whether changes that have occurred in stock status require adjustments to the conservation approach and management plan. The main indicators used for the assessment are taken from fishery statistical data, sampling of commercial catches and research surveys.

SUMMARY

- This science advisory report is valid for the 2010-2012 seasons unless some major changes occur in stock status.
- From 2007 to 2009, annual scallop landings in Quebec totalled an average of 91.4 tons of meat, a decrease of 25% compared to 2006. A reduction in fishing effort by 29% was also observed. Landings from the Magdalen Islands sector were at 52%, the North Shore at 41%, and the Gaspé Peninsula at 7%.

Canada

North Shore

- Iceland scallop landings on the North Shore dropped by 61% in 2007-2009 compared to 2006. The decrease was the result of a 60% drop in fishing effort due to an unfavourable socio-economic context.

- Areas 16A2, 16B, 16C, 16D, 16G, 16H and 18D were not harvested, and there was very little fishing effort in Areas 15 and 18A between 2007 and 2009. Commercial harvesting indices do not provide enough information to determine the status of the resource.

- Catches per unit effort in Areas 16A1, 16E and 16F were below the reference average (1992-2006).

- Research surveys in Area 16E in 2007 and 2008 indicated that the abundance of scallops larger than 70 mm was below average and that of scallops smaller than 70 mm was about average. In Area 16F, abundance indices have been dropping since 2004.

- Management by controlling harvesting effort in 2006 in Areas 16E, 16F and 18A was aimed at maintaining a steady exploitation rate in a situation where all the effort would be deployed. However, the indicators have been decreasing despite a drop in fishing effort, suggesting that the exploitation rate could be too high. For the moment, the maximum fishing effort should be maintained at current levels for 2010, 2011 and 2012.

- In Area 15, the potential harvesting effort includes a large number of unused licenses and likely far exceeds the stock's capacity to sustain exploitation. To avoid possible overfishing, it is recommended to reduce the potential fishing effort.

- Preventive TACs in Areas 16A1, 16A2, 16G and 16H are much too high in relation to historical landings. It is recommended to reduce them to prevent overexploitation, which could occur if all license holders deployed a maximum and sustained fishing effort.

Gaspé Peninsula

- Landings of sea and Iceland scallops from the Gaspé Peninsula dropped by 21% in 2007-2009 compared to 2006. The decrease was the result of a 37% drop in fishing effort.

- Fishing effort was very low or nil in Areas 17A1, 17A2, 18B2 and 18C from 2007 to 2009. Commercial indices do not provide enough information to determine the status of the resource.

- Sea scallops have been harvested in Area 18B1 since 2003. Catches per unit effort have been stable and the harvested scallops have been large.

- In Area 19A, following a decrease of harvesting capacity, the fishing effort has been low since 2002. From 2007 to 2009, landings and fishing effort were comparable to those of 2006. Catches per unit effort and the size of harvested scallops have been increasing since 2004 and are comparable to the average in 2009. This improvement in the status of the resource is the result of low exploitation since 2003. Therefore, the status quo is recommended in this area.

Magdalen Islands

- In 2007, because of concerns about the status of the resource, the potential fishing effort in Area 20A was reduced. It is now controlled by a maximum number of days at sea during the season.

- Sea scallop landings at the Magdalen Islands have increased by 166% for the 2007-2009 period compared to 2006. This increase in landings occurred without any increase in fishing effort.

- Catches per unit effort from 2007 to 2009 were significantly higher than that of 2006. This increase is explained by the access to scallop beds that had not been exploited for a minimum of 2 years. These closures of areas were intended to protect juvenile concentrations until they reached commercial size. In the short term, catches per unit effort should decrease.

- The 2009 research survey indicated that scallop abundance is comparable to the average (1987-2009), but has dropped sharply compared to 2008.

- It is recommended to increase the minimum catch size from 95 to 100 mm to increase the yield per recruit. The selectivity of the Digby scallop dredge should be adjusted accordingly so as not to catch scallops of less than 100 mm.

- Decision rules were established to determine the fishing effort. This effort is calculated using catch per unit effort from logbooks and abundance indices from the research survey.

- The maximum harvesting effort recommended for Area 20A in 2010 is 391 days at sea. This effort is to be reviewed annually after the indicators have been updated.

- The status of this population is still precarious. Results from the last three seasons are not guarantees for the future.

INTRODUCTION

Species Biology

There are two indigenous species of scallops in Quebec: the sea scallop (*Placopecten magellanicus*) and the Iceland scallop (*Chlamys islandica*). These two species are found mainly on gravel, shell or rocky bottoms, generally at depths of 20 to 60 metres. Iceland scallops occur along the North Shore, around Anticosti Island and off the north coast of the Gaspé Peninsula, but are virtually absent from the southern Gulf. In contrast, sea scallops are found primarily in the southern Gulf, including the Magdalen Islands and Chaleurs Bay, and occasionally along the Lower North Shore. Scallops are sedentary and live in aggregations known as "beds". This aspect of their biology needs to be taken into account when developing conservation strategies and harvesting plans.

Sea scallops grow in length more rapidly than Iceland scallops. Their growth rate varies from one Area to another and is affected by habitat quality and environmental conditions. In the Gulf of St. Lawrence, Iceland scallops reach commercial size at about age 8 (70 mm) and sea scallops at about age 6 (95 mm).

In scallops, the sexes are separate and eggs are fertilized externally. Scallop egg production is roughly proportional to its size cubed, with successful fertilization depending on the proximity of other scallops. The spawning period is short and does not occur at the same time throughout the Gulf. Along the North Shore and around Anticosti Island, spawning occurs between mid-July and late August, depending on the sector. Sea scallops spawn in August in Chaleurs Bay and beginning in late August around the Magdalen Islands.

Larval development takes about five weeks, from fertilization to settlement on the seabed. During this time, the larvae are dispersed throughout the water column. Juvenile scallops generally attach themselves to the seabed in proximity to the adults. Scallop beds are usually found in Areas where currents enhance larvae retention, but a good substrate is needed to ensure the successful attachment of juveniles. During the settlement period, juveniles are very sensitive to disturbance of the sediment by fishing gear. As a result, to ensure the survival of juvenile settled on the bottom, it is recommended that scallop beds not be dredged from August to November.

The meat yield by weight of a scallop of a given size varies over the reproductive cycle. Muscle weight peaks in spring just before gonad development, and drops to its lowest point during the spawning period, and starts rising again in the fall.

Description of the Fishery

In the Gulf of St. Lawrence, the scallop fishery is an inshore fishery. The Digby dredge is the most widely used. The commercial fishery is targeted at both scallop species. Catches are landed mostly as meat (muscle). The difficulty in visually distinguishing between the meat of the two species complicates the analysis of fishing statistics. However, the two species are not distributed uniformly in the Gulf of St. Lawrence, and catches in any one Area usually consist of just one species.

Since the late 1990s, the significance of scallop landings in the shell has been fluctuating. Because of the mixed nature of the landings (as meat or in the shell), a conversion factor (shell weight = 8.3 X muscle weight) has to be applied to quantify the catch under one form. In this report, landings have been expressed as meat.

Quebec waters are divided into 19 fishing Areas, which are grouped into three sectors, namely the North Shore (Areas 15, 16A1, 16A2, 16B, 16C, 16D, 16E, 16F, 16G, 16H, 18A, 18D), the Gaspé Peninsula (Areas 17A1, 17A2, 18B1, 18B2, 18C, 19A) and the Magdalen Islands (Area 20) (Figure 1). Few harvesters are active in Areas 15, 16A2, 16B, 16C, 16D, 16G, 16H, 18A and 18D, and there has been little fishing effort there, if any, of late. In 2009, 80 regular licences and 2 exploratory licences were issued. Management plans were developed for each Area, based on the following factors: vessel length, dredge size (<7.31 m), fishing season and hours, individual and overall quotas or number of fishing days permitted (Table 1).

A major change in the mode of fishery management in Areas 16E, 16F and 18A occurred in 2006. Harvesting is now managed by controlling the effort, i.e. by a limited number of fishing

days for the season and fishing hours per day. Moreover, given that fishermen have access to more than one fishing area, fishing operations at sea are monitored by a vessel monitoring system (VMS). Management based on the number of fishing days has also been applied to Area 20A of the Magdalen Islands since 2007.

From 2007-2009, the average annual landings totalled more than 90 t of meat, a decrease of 25% compared to 2006 (Figure 2). They came in order of importance, Magdalen Islands (52%), North Shore (41%) and Gaspé Peninsula (7%). During this same period, the fishing effort in Quebec decreased by 29% (Figure 3). The largest decrease was observed on the North Shore (60%) and then the Gaspé Peninsula (37%). The fishing effort at the Magdalen Islands was comparable to 2006.

Table 1. Scallop fishery management measures in 2009.

Area	Number of licences	Quota (t meat or day-at-sea)	Season (day/month)	Daily schedule	Coverage for dockside weighing	Hail out	Hail in	At-sea observers (% of trip)	VMS[1]	Limit size; Meat count
15	33 + 2[2]		14/05 - 31/12							
16A1	1	13.6 t	30/03 - 29/11				100 %	5 %		
16A2	1	6.5 t	30/03 - 29/11				100 %			
16B	2	6.8 t	30/03 - 15/11				100 %			
16C	2	11.8 t	11/05 - 25/10		100 %		100 %	10 %		
16D[3]		6.1 t	13/04 - 01/11				100 %			
16E	9	277 days	06/04 - 29/11	6h - 16h		100 %	100 %	10 %	100 %	
16F	9	164 days	06/04 - 29/11	6h – 16h		100 %	100 %	10 %	100 %	
16G	3	35.9 t	20/04 - 01/11				100 %			
16H	8	30.9 t	13/04 - 01/11			100 %	100 %			
17A1	1	10.9 t	01/04 - 30/11				100 %	5 %	100 %	
17A2	1	4.0 t	01/04 - 30/11				100 %		100 %	
18A	9	258 days	06/04 - 29/11	6h – 21h		100 %	100 %	10 %	100 %	
18B1	3		01/05 - 30/09				100 %		100 %	100 mm; 30 sca. / 454 g
18B2	3	16.0 t	01/04 - 30/11				100 %		100 %	
18C	3	11.0 t	01/04 - 30/11				100 %		100 %	
18D[4]		10.0 t	27/04 - 01/11				100 %			
19A	3		01/05 - 30/09	Day[5] and hour			100 %		100 %	100 mm; 30 sca. / 454 g
20	23	345 days	01/04 - 01/08 01/04 - 31/10	Day and hour		100 %	100 %			95 mm; 31 sca. / 500 g

[1] = Vessel Monitoring System (VMS).
[2] = Exploratory licence for Iceland scallops.
[3] = Open to fishers residing between Sept-Îles and Pointe-Parent.
[4] = Open to fishers residing between Tadoussac and Pointe-Parent.
[5] = Depending of days of week.

RESOURCE ASSESSMENT

The assessment of the status of scallop populations is based mainly on an analysis of commercial indices derived from logbooks or from sampling activities at sea or at dock-side. For scallop beds in the Mingan sector (Areas 16E and 16F) and the Magdalen Islands, it also incorporates indices derived from the research surveys that are carried out every two years.

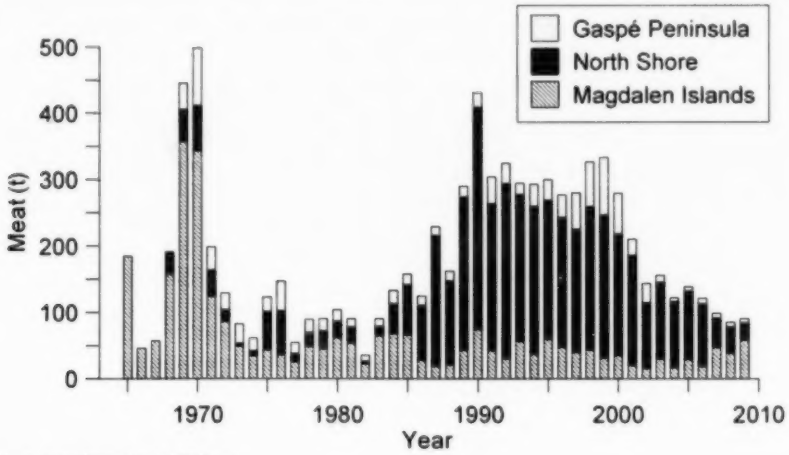

Figure 2. Scallop landings in Quebec.

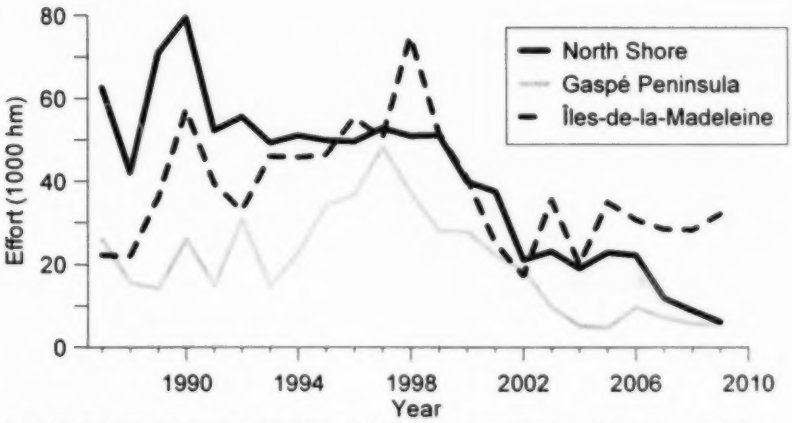

Figure 3. Fishing effort in Quebec (standardized fishing hour per meter of dredge width).

North Shore

Iceland scallops are harvested along the entire north shore of the Gulf of St. Lawrence, while sea scallops are taken only along the Lower North Shore. The North Shore is subdivided into 12 fishing Areas located between the mouth of the Saguenay River and Blanc Sablon. Landings on the North Shore totalled around 26 t of meat in 2009. Compared to 2006, the average annual landings were down by 61% from 2007-2009, and the fishing effort dropped by 60%. The majority of these landings come from the Mingan Archipelago sector (Areas 16E and 16F).

Upper North Shore (Scallop Management Areas 16A1, 16A2, 16B and 16C)

Landings from the Upper North Shore Areas totalled 3.4 t in 2009 and consisted entirely of Iceland scallop (Figure 4). There were no landings recorded for 2007 and 2008. These areas are harvested by five fishers and the fishing effort is low and controlled by the number of licences issued and quotas.

There was no harvesting in Areas 16A2, 16B and 16C in 2009, and there was only a limited fishing effort in Area 16A1. The recorded CPUE on the northern portion of the scallop bed of Ile Rouge, 16A1, was low in 2009 (Table 2), as well as the size of the scallop landed (Table 3).

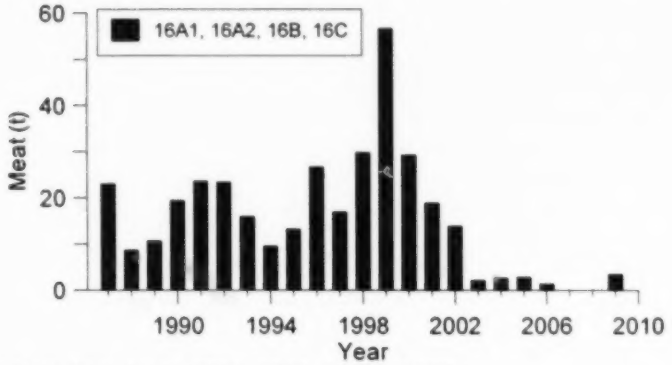

Figure 4. Scallop landings from Areas 16A1, 16A2, 16B and 16C.

Table 2. Catch per unit of effort (kg of meat per hour of fishing and meter of dredge width) estimated from logbooks for the North Shore areas.

	Fishing areas										
Year	**15**	**16A1**	**16A2**	**16B**	**16C**	**16D**	**16E**	**16F**	**16G**	**16H**	**18A**
2000	3.80	7.15	2.17	3.06	6.37		4.81	4.95	2.40		3.60
2001	1.64	6.14	2.90	2.32	3.02	0.24	4.83	6.94	1.45		3.86
2002	1.31	18.91			8.00	3.43	4.39	5.66			3.21
2003	1.64	4.62		1.16		0.76	6.66	5.50	3.63		3.70
2004	2.10	3.30	0.95	0.74		3.70	5.27	7.44	4.05	2.79	3.21
2005	2.04	2.69	1.92				5.21	5.96	3.95		3.62
2006	2.65	1.09	0.41				5.27	4.74			2.94
2007	1.75						4.08	3.07			2.32
2008							5.08	3.46			2.21
2009	1.95	2.54					5.19	2.63			0.95
Mean 1992-2006	1.78	6.31	1.58	1.79	5.52	1.74	5.85	5.37	2.95	2.81	4.24

Middle North Shore (Scallop Management Areas 16D, 16E, 16F, 16G and 18A)

Nine fishing licences provide access to Areas 16E, 16F and 18A, four for Area 16G, and all Middle North Shore scallop harvesters have access to Area 16D. Each Area is regulated by a quota, and there are daily and seasonal restrictions on fishing effort. Landings from the Middle North Shore only reached 22.4 t in 2009, the lowest value since these Areas began being harvested (Figure 5).

Table 3. Modal size of scallop harvested in the North Shore Areas based on the sampling of commercial catches.

	Fishing areas										
Year	**15**	**16A1**	**16A2**	**16B**	**16C**	**16D**	**16E**	**16F**	**16G**	**16H**	**18A**
2000		80	82		78		88	78			80
2001		75	82		80		88	83			81
2002		74					87	88			83
2003		85					87	87			84
2004		87					87	83			82
2005	90	84					88	83			82
2006		81	87				86	86			83
2007							82	81			
2008							81	80			
2009		78					79	82			
Mean 1992-2006	85.8	80.8	83.7		80.1		88.0	83.9	76.6	80.7	83.3

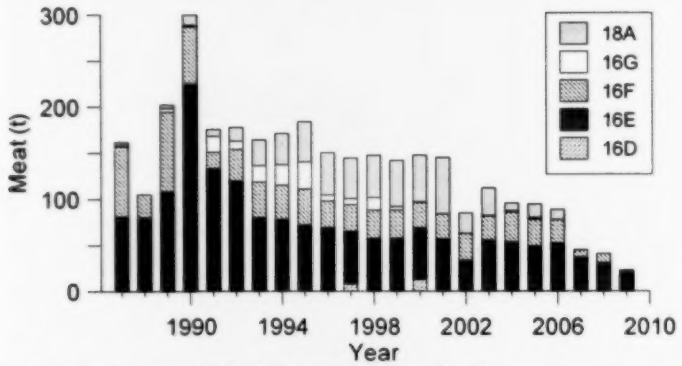

Figure 5. Scallop landings from Areas 16D, 16E, 16F, 16G and 18A.

From the Manitou River to the Île aux Perroquets lighthouse (Area 16D), there has not been any fishing effort since 2005. Since 1996, landings and yields have been low because of the sporadic nature of the fishing effort in this Area.

In Area 16E, landings dropped from 52 t of meat in 2006 to 21 t in 2009 (Figure 5). During the same period, fishing effort dropped steadily from 257 days at sea to 101 days, despite an authorized total of 277. In 2009, fishing effort was primarily concentrated on a single scallop bed, where strong cohorts recruited to the fishery beginning in 2007. This recruitment had previously been identified as of 2003 during the research surveys. Catches per unit effort from the logbooks were below the 1992-2006 average. The modal size of scallops landed from 2007 to 2009 was very low, or 81 mm on average compared to the historical average of 88 mm (Table 3). This decrease in size at landing coincided with the harvesting of the scallop bed where strong cohorts had just recruited to the fishery.

The 2008 research survey showed that the density of commercial size scallops was below the 1990-2007 average and the density of non-commercial size scallops was above average (Figure 6). The modal size of commercial size scallops was 80 mm (Figure 7), and it was the lowest value observed in this survey. The abundance of scallops between 40 and 60 mm, which

represents the medium-term recruitment, was less than what had been observed between 2003 and 2007 (Figure 7).

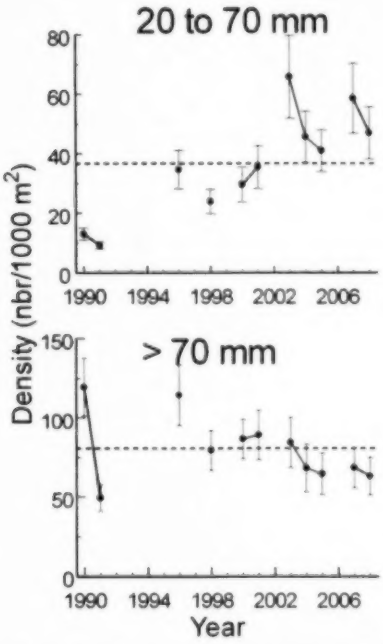

Figure 6. Density index of commercial (> 70 mm) and non commercial (20 to 70 mm) scallops based on research surveys in the Mingan sector, Area 16E (± standard error). The dotted line represents the average for the 1990-2007 series.

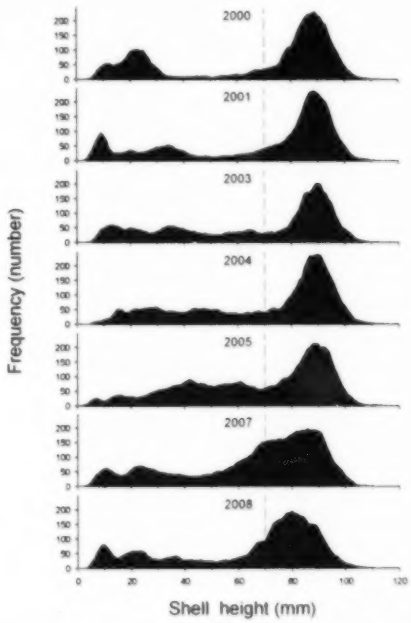

Figure 7. Size structure of Iceland scallops sampled south of the Mingan Islands (Area 16E) in the research surveys since 2000.

Landings have decreased significantly in Area 16F between 2006 and 2009, from 25 t of meat to 2 t (Figure 5). During this same period, fishing effort declined steadily from 120 days at sea to 14 days despite an authorized total of 164. The CPUE from logbooks have been declining since 2004 and in 2009 they reached the lowest value of the historical series. The modal size of scallops landed from 2007 to 2009 was low, or 81 mm on average compared to the historical average of 84 mm (Table 3).

In Area 16G, between Johan Beetz Bay and Natashquan, landings, fishing effort and catches per unit effort varied until 2005, (Table 2, Figure 5) and there have been no landings since.

Between 2007 and 2009, Area 18A was only harvested between one and three days out of a possibility of 258 days at sea. Therefore, landings were almost nil for this period (Figure 5).

Lower North Shore (Scallop Management Areas 16H and 15)

In 2009, 8 scallop fishing licences were issued for Area 16H, and 33 regular and 2 exploratory licences were issued for Iceland scallop giving access to Area 15. Prior to 1992, most of the scallops landed on the Lower North Shore were sea scallops, but from 1992 to 1998, Iceland

scallop landings from Areas 16H and 15 increased. Since 1998, landings of the two scallop species have fallen on the Lower North Shore, totalling only 0.3 t of meat in 2009 (Figure 8).

There has been no fishing effort in Area 16H since 2004. The steady catches per unit of effort (from logbooks) in Area 16H are inconsistent with the lack of harvesting (Table 2).

From 2007 to 2009, there was little fishing effort in Area 15. Landings dropped from 5.2 t in 2006 to 0.3 t in 2009 (Figure 8). In 2009, the CPUE was comparable to the mean CPUE from the 1992-2006 series (Table 2).

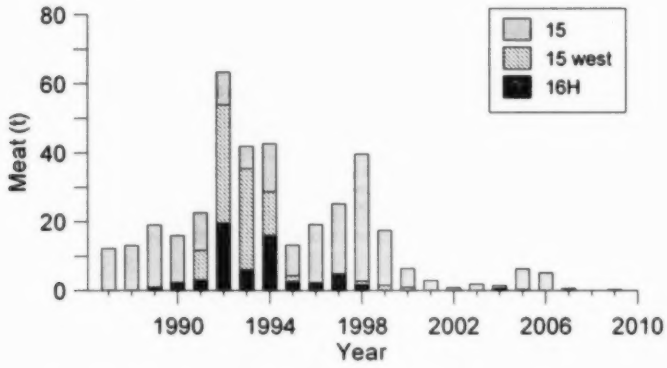

Figure 8. Scallop landings from Areas 16H and 15 of the Lower North Shore.

Gaspé Peninsula (Scallop Management Areas 17A1, 17A2, 18B1, 18B2, 18C and 19A)

The Gaspé Peninsula is composed of three fishing sectors: the St. Lawrence Estuary and north shore of the Gaspé Peninsula (17A1, 17A2 and 18B1), Anticosti Island (18B and 18C) and Chaleurs Bay (19A). The number of licenses is limited in each Area. In 2009, only one licence was issued for Areas 17A1 and 17A2, three in Areas 18B1, 18B2 and 18C and another three in Area 19A. Each area has its own fishing season, and quotas were set in Areas 17A1, 17A2, 18B2 and 18C.

Landings in the Gaspé Peninsula increased steadily between 1993 and 1999, when they reached an all-time high of about 80 t of meat. Gaspé Peninsula landings then dropped, hitting a record low of 5.5 t in 2004 (Figure 9). Since, Gaspé Peninsula landings have been steady and in 2009, they totalled 5.6 t of meat. Average annual landings between 2007 and 2009 dropped by 21% compared to 2006, while fishing effort decreased by 37%.

There have been no harvesting activities in Areas 17A1, 18B2 and 18C since 2000, 2002 and 2004 respectively.

There was only minimal harvesting effort north of the Gaspé Peninsula (Area 17A2) between 2007 and 2009. Catches per unit of effort (CPUE) estimated from the logbooks was below the 1992-2006 series average (Table 4). The weight of the meat at landing was below the reference average.

Since 2002, on the north shore of the Gaspé Peninsula (Area 18B1), there has been a directed fishing effort on sea scallops. Landings and CPUE have been stable (Table 4). Large size sea scallops have been harvested in this area and the modal size is 123 mm (Table 5).

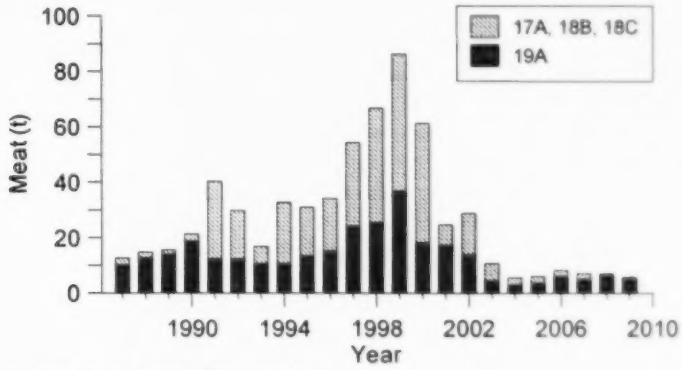

Figure 9. Scallop landings from Gaspé Peninsula.

Following a drop in fishing effort in Area 19A in 2003, landings have remained stable and totalled 5 t in 2009 (Figure 9). Moreover, the catch index per unit effort has been increasing since 2003 in Area 19A (Table 4). The size of sea scallops landed between 2007 and 2009 is greater than 1992-2006 series average (Table 5).

Table 4. Catches per unit of effort (kg of meat per fishing hour and meter of dredge width) estimated from logbooks for Gaspé Peninsula Areas.

	Fishing areas					
Year	**17A1**	**17A2**	**18B1**	**18B2**	**18C**	**19A**
2000	7.01	1.56		15.65	8.08	0.91
2001		1.62				0.97
2002		1.29		5.53	6.99	1.01
2003		1.22	1.43	1.29	4.85	0.70
2004			2.30		1.80	0.72
2005			5.47			0.83
2006		0.62	2.03			0.85
2007		0.48	2.61			0.92
2008			2.37			1.12
2009		0.56	2.71			0.97
Average 1992-2006	7.28	1.37	1.74	3.92	4.18	0.95

Table 5. Modal size of scallops harvested in Gaspé Peninsula Areas based on commercial catch samples.

	Fishing areas					
Year	**17A1**	**17A2**	**18B1**	**18B2**	**18C**	**19A**
2000	78	85			78	105
2001		90				92
2002		92			77	112
2003		95			85	110
2004			118		78	95
2005			130		80	100
2006		95	120			98
2007		86	128			108
2008			128			106
2009			122			115
Average 1992-2006	79.0	89.9	122.7	82.5	80.1	104.5

Magdalen Islands (Scallop Management Area 20)

The Magdalen Islands comprise a number of scallop beds, namely the following seabeds: Étang du Nord (Pointe-du-Ouest), Dix-Milles, Chaîne-de-la-Passe, Sud-Ouest, Île Brion and Banc de l'Est (Figure 10). Subarea 20E is closed to fishing year-round, as it is a refuge area for sea scallop. The Chaîne-de-la-Passe and part of the Étang du Nord seabeds were aquacultural sites reserved for scallop seeding until 2006.

Since 2007, the fishing effort in Area 20A has been controlled by a number of authorized days at sea and a season in Areas 20B and 20F. The effort authorized in 2007 was 275 days and 345 days in 2008 and 2009. These maximums were almost met each year. The annual fishing effort has been stable since 2001 and below the 1992-2006 series average. Landings rose sharply in 2007, increasing from 18 t to 46 t of meat (Figure 11). Since 2007, landings have been higher than the reference average because of the successive reopening of three fishing grounds. The Dix-Milles, closed in 2005 due to high abundance of sub-legal size scallop, was reopened in 2007 and most of the fishing effort has been directed. In 2008, the Pointe-du-Ouest was closed due to the presence of small scallops while part of the Chaîne-de-la-Passe, seeded in 2003 by a private company, was reopened to fishing. The 2008 fishing effort occurred on this bed and on the Dix-Milles bed. In 2009, the Pointe-du-Ouest was reopened and most of the fishing effort was deployed.

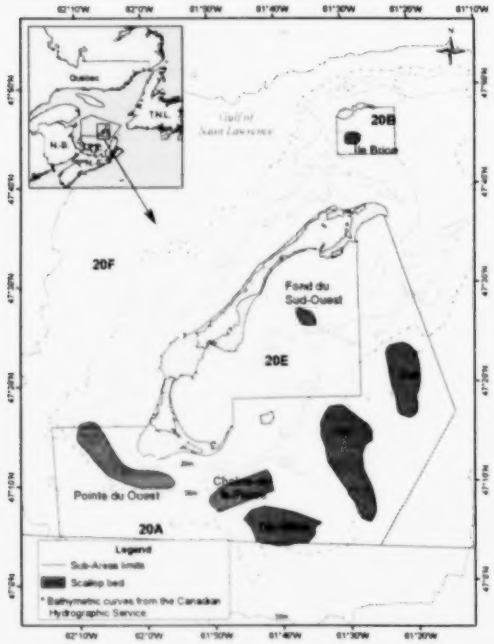

Figure 10. Sub-areas and main scallop fishing grounds in the Magdalen Islands.

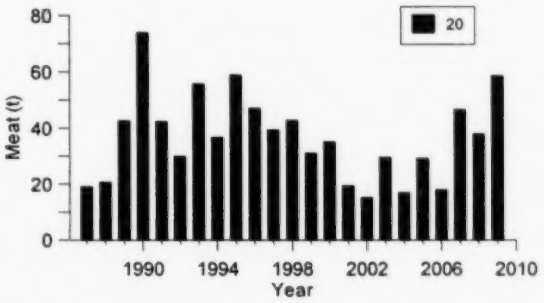

Figure 11. Scallop landings in Magdalen Islands.

According to logbook data, catches per unit effort estimated in 2007, 2008 and 2009 were above the upper reference level (Figure 12). Such CPUE had not been observed since 1983. This significant increase in CPUE is due to the exploitation of areas that had not been harvested for a minimum of 2 years and where high recruitment had been observed.

According to the August research survey, the abundance of commercial size scallops and those that will reach commercial size during the 2010 season (85-100 mm) significantly decreased following the 2009 fishing season (Figure 13). For these size classes, abundance is comparable to the 1987-2008 series average. Medium-term recruitment (70-85 mm and <70 mm) was average and below what had been observed in the early 2000s. In August 2009, the highest concentrations of juvenile scallop were observed north of the Pointe-du-Ouest bed.

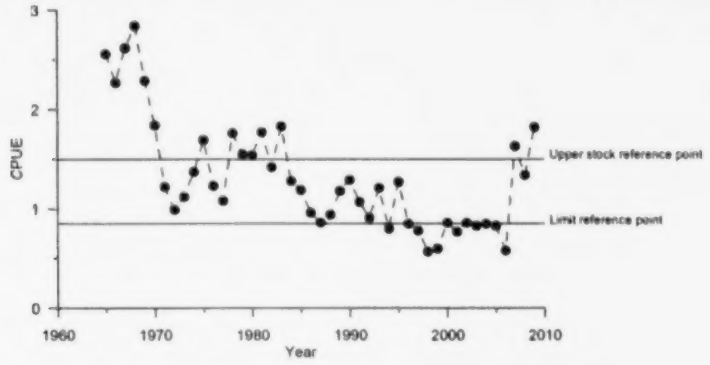

Figure 12. Catch per unit of effort (CPUE) estimated from logbooks in Area 20.

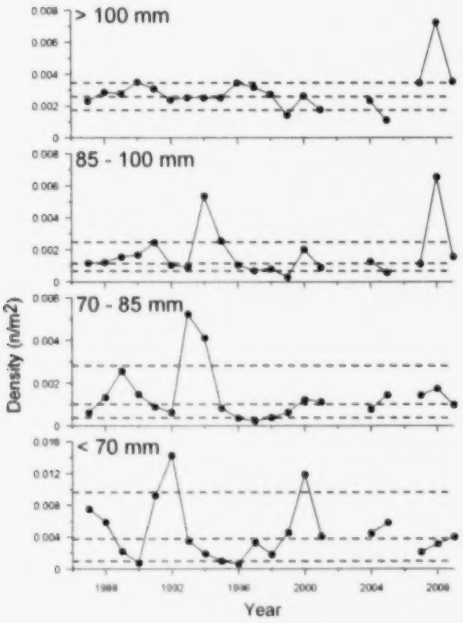

Figure 13. Density of sea scallops sampled at the Magdalen Islands during the research surveys according to size categories. The dotted lines indicate the 15th, 50th and 85th percentiles of the 1987-2008 series.

In 2007, the DFO and scallop harvesters had given themselves as targets to determine indicators for monitoring the fishery and find a way to determine the fishing effort. Several meetings took place between 2007 and 2009 to determine the decision rules for determining fishing effort. The chosen method for determining fishing effort has two phases. First, the effort is determined by the CPUE of the last two seasons. If the CPUE of the last year is higher than the previous year, the average of two values is kept. Otherwise, only the CPUE of the last year is used. The chosen CPUE is placed on Figure 14 in order to determine if it is low, average or high, and to determine the fishing effort for the following year. Subsequently, according to results of most recent research survey, the effort is adjusted upwards or downwards, in the grey

area in Figure 14. This method must be applied annually. For the 2010 season, the maximum fishing effort would be 391 days at sea in Area 20A

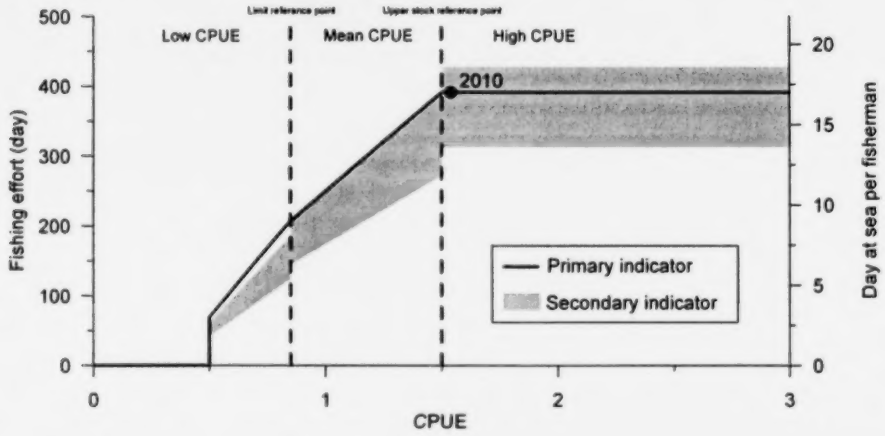

Figure 14. Determining fishing effort (days at sea) according to primary (CPUE) and secondary (research survey indices) for Area 20A.

In December 2009, a research survey was conducted in Area 20A. This survey was conducted under the Fisheries Science Collaborative Program (FSCP) and with the help of the Magdalen Islands Scallop Fishermen's Association. A first objective was to compare the catches made in December to those made during the survey conducted the previous August, on account fishermen were arguing that August survey was not representative of the abundance of scallops. Catches were significantly higher in December at each station, but the structure of the population was comparable. Since 1987, the research survey in this area has always been conducted in late August, given the length of this series and that the indices are interpreted relatively, it was advised to continue the survey in August. A second objective of this survey was to determine the selectivity of the dredge with 82 mm rings that Magdalen Islands fishermen use. The results showed that the dredge begins catching scallops measuring 75 mm shell height and it also successfully catches all scallops of 90+ mm (Figure 15). Given the objective of reducing the harvesting of scallops smaller than 100 mm without reducing yields for scallops measuring more than 100 mm, an increase of ring diameter to 89 mm would be justified, as the 2005 study showed.

The efficiency of the Digby dredge used in the Magdalen Islands was estimated by various methods. The methods used data from the commercial fishery or from research surveys. Nine estimates were obtained; the dredge's efficiency varies between 45 and 72%. Therefore, the efficiency of the dredge would be about 50%. Figure 16 shows an example of data used, and the CPUE decreases significantly as fishing effort accumulates. Information on the selectivity of the dredge provides a more accurate assessment of the density of scallops on the seabed from research survey data or from the commercial fishery.

Sources of Uncertainty

The current assessment is based on indices derived from logbooks and commercial catch samples at sea and dockside. In addition, in Areas 16E, 16F and 20, scientific surveys are

conducted every two years. With no knowledge of exploitation rates, it is difficult to adjust the quotas or exploitation strategies other than with a cautious approach.

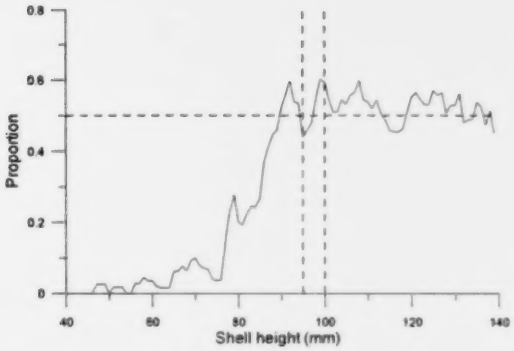

Figure 15. Selectivity of the Digby dredge in the Magdalen Islands in 2009 with 82 mm rings. The dotted lines indicate the 95 and 100 mm sizes.

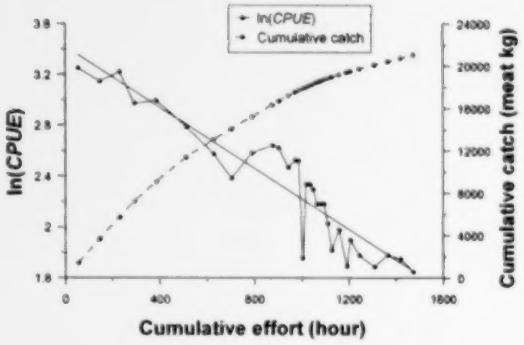

Figure 16. CPUE natural logarithm and cumulative catches according to cumulative fishing effort in 2007 on the Dix-Milles scallop bed.

CONCLUSIONS ANS ADVICE

North Shore

Since the late 1980s until 2006, scallop landings from the North Shore have always represented more than 65% of Quebec catches. This proportion has fallen sharply since 2007 due to poor socio-economic conditions for the scallop fishery in this region. Therefore, fishing effort has significantly declined on the North Shore. This downward trend began in the early 2000s.

Scallop Management Areas 16A1, 16A2, 16B, 16C, 16D, 16G, 16H and 18D

Few harvesters are active in Areas 16A1, 16A2, 16B, 16C, 16D, 16G, 16H and 18D and fishing effort has been limited, varying from year to year. Information on these areas is incomplete and insufficient, which does not allow for an adequate assessment of the resource status.

Over the years, preventive quotas have been arbitrarily set for certain fishing areas. In several cases, the quotas have never or almost never been met. Since these quotas are well above the landings, they do not moderate harvesting in the related areas. It is therefore recommended to reduce them to more appropriate levels in Areas 16A1, 16A2, 16G and 16H.

Scallop Management Areas 16E, 16F and 18A

Managing the effort by controlling the number of days at sea, developed in 2006 for areas 16E, 16F and 18A was to keep the exploitation rate constant in a situation where all fishing effort was deployed. Constant effort meant a constant exploitation rate and the annual landing would fluctuate depending on the status of the stock. Since its introduction, maximum effort has never been reached in all three areas. Some fishermen have stopped harvesting certain areas or are not active. Therefore, Area 18A was not harvested between 2007 and 2009, Area 16F was only marginally harvested during this period and in Area 16E, the most accessible to fishermen, a

decrease of fishing effort was observed. In Area 16E, the fishing effort in 2009 was concentrated on a single bed; normally the fishing effort is more evenly deployed on all scallop beds in this area. Despite these reductions in fishing effort, resource indicators seem to show signs of population decline, suggesting that the exploitation rate could be too high. For the moment, given the significant decrease in fishing effort, the authorized fishing effort for 2009 should be maintained for 2010, 2011 and 2012. During this period, discussions will have to take place between the DFO and Industry to review the exploitation rates in these areas.

Scallop Management Area 15

For several years, landings from the Lower North Shore (Area 15) have remained low. The information on this Area is incomplete and insufficient. Therefore, it is difficult to rule on the status of the resource. Productivity seems low, recruitment of both scallop species is sporadic and mass sea scallop mortalities are observed regularly.

Given the limited productivity of scallop populations in Area 15, the large number of fishing licenses likely represents an overcapacity of effort in relation to the capacity of the stocks. It is therefore recommended to reduce the potential fishing effort on the Lower North Shore.

Gaspé Peninsula

Few harvesters are active in Areas 17A1, 17A2, 18B2 and 18C and fishing effort has been limited, varying from year to year. Information on these areas is incomplete and insufficient, which does not allow for an adequate assessment of the resource status.

A sea scallop fishery on the north shore of the Gaspé Peninsula began in 2002 (Area 18B1). Fishing effort has remained low, which has helped maintain landings and certain stability in terms of CPUE. Therefore, it is recommended to maintain the same fishing effort.

The measures that were adopted in 2001, such as the decrease in the number of fishers and the gradual increase in the minimum legal size to 100 mm in Chaleurs Bay (Area 19A), were implemented with the aim of reducing fishing effort and increasing the stock's reproductive potential. The impacts are beginning to be felt as the CPUE has increased and landings are stable. These measures must be maintained because they contribute towards improving the status of the resource.

Magdalen Islands

The Magdalen Islands scallop population declined for about 20 years to a very low abundance level in 2006. In 2007, the potential fishing effort in Area 20A was reduced and controlled by a maximum number of fishing days at sea. Landings and CPUE have been above average over the last three fishing seasons. Such results had not been observed for over fifteen years. This improvement is due to the fact that fishermen had access to scallop beds that had not been harvested for at least two years. These beds had been closed because of concentrations of juveniles or seeding activities. Fishing yields have thus been excellent since they reopened and CPUE have remained at a high level because of tighter control of fishing effort.

The expected medium-term recruitment is lower than that observed in the early 2000s. It is therefore likely that CPUE decrease in the short term. The status of this population is still precarious, given its high dependence on recruitment. The method used for determining the

fishing effort will be applied for upcoming seasons, and it will then be evaluated and adjusted as necessary. For the 2010 season, the maximum recommended fishing effort is 391 days at sea.

In order to increase performance per recruit and reproductive potential, it is recommended to continue increasing the minimal catch size to 100 mm. The use of a Digby type scallop dredge with 89 mm rings should help respect these objectives.

OTHER CONSIDERATIONS

Conservation Measures

The conservation measures recommended for scallops are intended to maintain the capacity of all the beds to replenish themselves and to ensure their sustainability. Any approach designed to boost reproductive potential, whether by leaving more adults on the seabed or by creating refuge areas for spawners, should have a positive effect on conservation of the resource. Moreover, because the number of eggs a scallop produces is roughly proportional to its size cubed, allowing the population to age and the scallops to grow more should result in a net gain in productivity, with the concomitant benefit of increasing the yield per recruit, and hence commercial profitability.

Scallops spawn in late summer, and juveniles settle on the seabed in the fall. Dredging the beds with fishing gear at this time of year reduces reproductive potential and stirs up the sediment, which can interfere with successful settlement of juveniles. Halting harvesting activities during the spawning and settlement periods (August to November) would limit the adverse effects of dredging on the substrate and benefit the survival of young scallops. Thus, a strategy for protecting seabeds where juveniles are very abundant should be promoted. Subsequently, these areas could be closed to fishing until the cohorts have reached commercial size in order to maximize the yield per recruit and minimize incidental scallop mortalities.

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